COMMANDER'S DIGEST
VOL. 18, NO. 16, OCTOBER 16, 1975
MAXIMIZE PERFORMANCE
– MINIMIZE COST
INCREASE RANGE
LIFE CYCLE COSTING
100 o/o
DESIGN TO MAINTAIN
RETURN ON INVESTMENT
MAXIMIZE MILITARY UTILITY
ZERO BASE
MEAN TIME FAILURE
MANAGEMENT BY OBJECTIVES
NEAR TERM VS LONG RANGE
IMPROVE PAYLOAD
REDUCED MANNING
MORE BANG FOR A BUCK
TECHNOLOGY GAPS
COST EFFECTIVENESS
TECHNOLOGY TRANSITION
CONSERVE CRITICAL RESERVES
DIRECTED REQUIREMENT (SACRED COW)
TECHNOLOGY COUPLING

LIFE CYCLE COSTING . . . Beyond the

Life Cycle Cost (LCC) and Design to Cost (DTC) are far more than current Department of Defense "buzz words." Rather, they are the keystones of our strategy for a better Defense materiel acquisition process—a process that must succeed, if we are to provide this Nation with a credible defense at an affordable cost. In my opinion, these concepts equate to our survival as a Nation.

As Secretary Schlesinger pointed out in his address to the graduating class at the Air Force Academy: ". . . there is no adequate substitute for the United States as the mainstay and the maintainer of the community of free states. . . . Detente . . . which we will actively pursue, will, by necessity, remain undergirded by an equilibrium of force."

While Congress appears pursuaded by the Secretary's arguments, thus far cutting less deeply into our FY 76 budget request than in prior years, our projections for the future forecast a worsening DoD budget squeeze, as the pressure to find resources for non-Defense programs increases almost asymptotically. Chart 1 shows DoD's share of the Federal Budget—this share has dropped from 42 per cent in FY 1964, the last pre-Vietnam year, to 26 per cent in FY 76, and is expected to drop further by 1980.

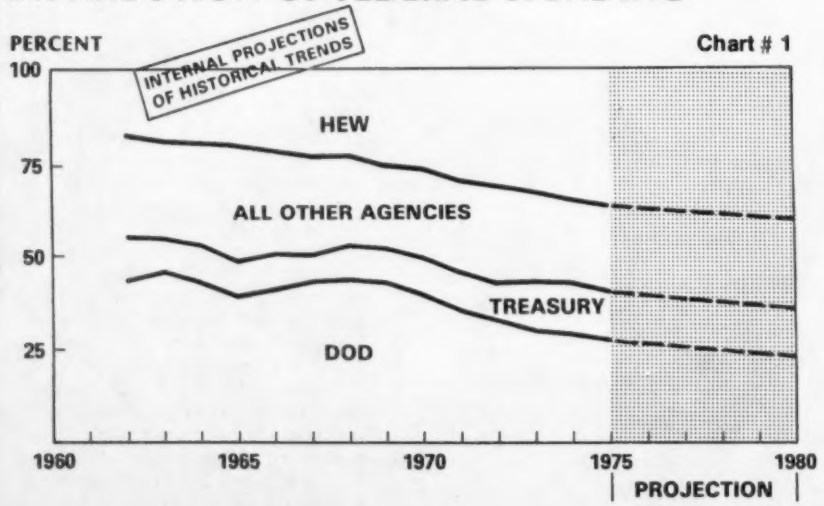
A 40 year profile of the Defense budget, in constant FY 76 dollars is indicated in Chart 2. The shaded area represents war costs and the cost of past wars—consumables and equipment attrition for Korea and Vietnam, plus retired military pay and health care. The unshaded area—real program value or RPV—represents that portion of the DoD budget that enables us to provide a present deterrence or war-fighting capability.

Defense real program value has been eroding downward steadily at roughly $1 to $1.5 billion/year in constant-dollar terms since 1962. There is a widening divergence between an extrapolation of this trend and what might be considered adequate funds for a modern war-fighting capability.

The FY 76 DoD budget request by titles of the Appropriation Act is shown in Chart 3. Over half is for people and people-related areas. This means less dollars can be devoted to force modernization—roughly one third.

The 20-year trend in distribution of major portions of the Defense budget is indicated in Chart 4. The increasing proportion going to people costs is a trend we are working diligently to reverse. In FY 76, only the 24 per cent for procurement and the 10 per cent for research, development, test and evaluation (RDT&E) go for force modernization, whereas the Soviets spend over half their defense budget for force modernization. Thus, a major R&D thrust must be to reduce the proportion of the DoD budget devoted to people costs and operating and support costs, thereby freeing funds for force modernization.

DISTRIBUTION OF FEDERAL SPENDING



'Buzz Word'

By Robert E. O'Donohue, Jr.
Assistant Director for Planning
Office, Director of Defense
Research and Engineering

Soviet defense expenditures have exceeded ours since 1971, and are projected to exceed ours by about one third in 1976 (Chart 5). The Soviet military outmans us by almost 2:1, and has been outproducing us by over 6:1 in several land forces systems, and by over 3:1 in naval surface ships and nuclear submarines, as shown in Chart 6.

The cost of our weapon systems has increased dramatically. As shown in Chart 7, tank costs have grown 4.8 per cent per year every year since 1940, *without* inflation.

There are similar trends for utility and attack helicopters—4.3 per cent per year since 1950, and, for strategic missiles—4.8 per cent per year, compounded, since 1960. And worst of all is jet fighters (see Chart 8), growing at 10 per cent per year until the F-15, which was our first attempt to bend down the slope of this curve. Only with the F-16 and F-18 does the slope drop to 5.3 per cent per year. The average growth over all DoD systems has been about 5.5 per cent per year, *without* inflation, though, in the last year or two, largely through our initial design-to-cost efforts, this rate of increase has been tending to lower values.

The cost of successor equipment, the real product of R&D, has been increasing at such a rate that we are presently unable to field and support new equipment on a one-for-one basis, and even if our present efforts at DTC and LCC succeed, we will be unable to do so for the foreseeable future. This has led to the "hi-low mix" notion, with a portion of the forces "all singing and all dancing" and the balance designed to be "affordable" at low cost to fill the inventory objective, such as the F-15/F-16 mix in the Air Force and F-14/F-18 mix in the Navy.

Another approach to the low end of the mix is to "go commercial." We are doing this in electronic test equipment, inertial equipment, cargo trucks and communications equipment, just to mention a few. Going commercial in DoD does not stop at the loading dock, for DoD, like any other tough customer, will insist on warranty provisions or other LCC incentives to complement the line item procurement savings.

Simply allocating more money to a few high-priority programs to buy more is not the answer, because the cost of all successor programs is rising, and there simply isn't enough money to go around. The message is clear: Unaffordable programs will have to be cancelled.

"Lock In" Early

The absolute necessity for an active DDR&E role in addressing the LCC projections of a new weapon or

Robert E. O'Donohue, Jr., is the focal point within the Office of the Director of Defense Research and Engineering (ODDR&E) for planning and analysis to define a balanced overall Research, Development, Test and Evaluation (RDT&E) Program in the 2-5 year time period that is consistent with the long-term 6-15 years force structure needs and expected fiscal constraints. He is also responsible for assuring an awareness of the life cycle cost implications of research and development (R&D) decisions, and for application of design-to-cost policy and other appropriate acquisition management tools in the acquisition of subsystems, with emphasis on electronics acquisition management.

A major area of Mr. O'Donohue's activity is implementing the recommendations of the Electronics X Study, such as design-to-cost, improved standardization, reliability improvement warranties, and improved life cycle cost visibility. He is also the Executive Officer of the Defense Science Board, thereby providing a real-time interface between the DoD RDT&E Program and the scientific community.

He joined ODDR&E in 1967 as Staff Assistant (Tactical Avionics); in 1970 he became Senior Staff Specialist (Air Superiority Systems); and in 1973, Acting Assistant Director (Air Warfare). He came to ODDR&E from Grumman Aerospace Corporation where he was Chief of Preliminary Systems Engineering.

Mr. O'Donohue holds a Bachelor of Electrical Engineering degree from the Polytechnic Institute of New York and a Master of Science in Management from the Massachusetts Institute of Technology, the latter as an Alfred P. Sloan Fellow.

system is indicated by Chart 9. It conceptually illustrates the fact that early design and program decisions virtually determine life cycle costs. There is general agreement that over two thirds of the life cycle cost of a typical system is determined by the end of the conceptual phase, even before the first meeting of the Defense Systems Acquisition Review Council (DSARC) on the system—the so-called Milestone I DSARC.

While in certain selected cases, such as the A-10's TF-34 engine, cost savings can be made by major relaxation of requirements on already-designed hardware; in general, by the time the Validation Phase is completed, and a specific piece of hardware is to enter engineering development, that hardware, by its very nature, leaves little flexibility in changing the final life cycle costs. Most of a system's life cycle cost is essentially determined by the time of DSARC II.

Conversely, early R&D costs are highly leveraged. On the average, about half a program's life cost is in operations and support costs; a relatively small percentage of dollars devoted in the Validation Phase to lowering O&S (or production) costs can result in a significant return on investment. (See Chart 10)

Tackling Cost Drivers

Fortunately, we think we have an insight into the cost drivers and it is the role of DDR&E to collar them at the outset of any program. The items shown here are not necessarily the big hitters on every program, but they are sufficiently illustrative of the problem and the areas in which DDR&E takes the lead responsibility.

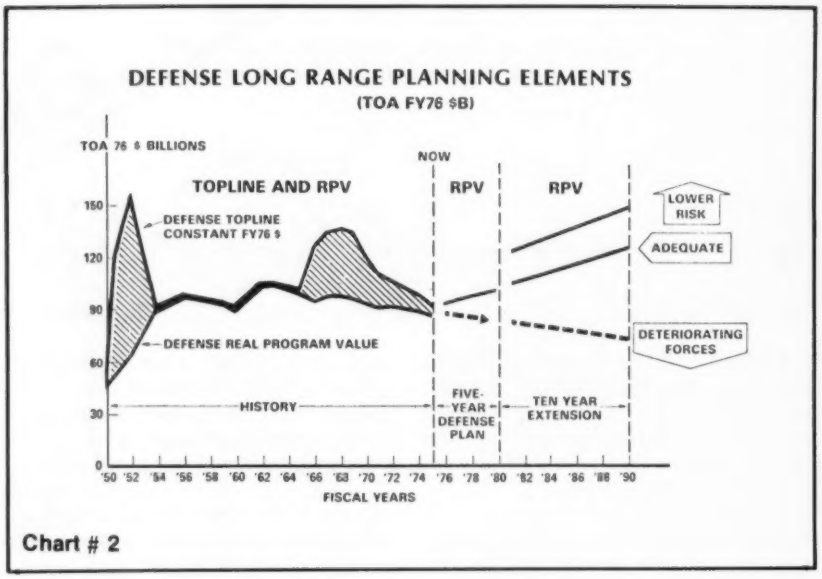
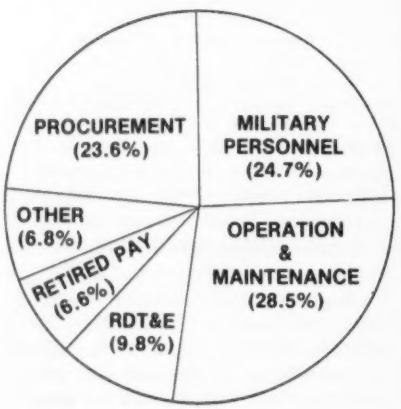


Chart # 2

• **Performance requirements**—challenging the user's "requirements" every step of the way, and trading ultimate capability against cost. We've been pinging on the engineers for years to achieve higher performance at virtually any cost. We need a "cultural revolution" where cost is at least an equal partner with performance. This means sensitizing the designer, and the user, to the potential life cost impact of the initial design concept, so that needed tradeoffs can be made early, when they can have a real impact on life cost. It is imperative that manufacturing, estimating and support personnel work with the designer and user in the earliest conceptual stages, to enable this sensitizing process to take place, and so that meaningful trades can be made.

• **Technology**—getting the right level in the new weapon system. This is a further part of the "cultural revolution"—to keep both the buyer and seller from falling prey to the "because we can we must" syndrome (also called the "technological imperative"), which is all too often synonymous with the application of new technology not to lower costs, but to push

DOD FY 1976 BUDGET
BY BUDGET TITLE



	($ MILLIONS) FY 1976
MILITARY PERSONNEL	25,914
RETIRED PAY	6,936
OPERATION & MAINT	29,846
PROCUREMENT	24,720
RDT&E	10,294
MILITARY CONST	2,901
FAMILY HOUSING	1,282
MILITARY ASST	2,701
CIVIL DEFENSE	88
FOREIGN CUR PROG	3
	104,684

Chart # 3

performance regardless of cost. We should not restrain technological development, but rather place it in the right perspective. Usually, pushing performance dictates the use of new and unproved technology, which all too often is short on performance and long on support cost.

• **Specifications**—must be applied rationally, not across the board, as is too often the case now. The appropriate use of specifications and standards can result in an excellent LCC return on investment, especially those that permit orderly technological growth. For example, the Services, working at the behest of DDR&E, have developed a command-response multiplex standard (MIL-STD-1553A) which will be used on the F-16 and 18 and in any other command-response multiplex requirement.

The data transfer technique prescribed by this standard will permit the rapid integration of system baseline equipment and outyear changes without the attendant costs normally associated with a Class V wiring change. More significantly, appropriate standards provide the means for integrating competitive solutions to requirements for the conduct of low-cost "fly-offs".

Another important DDR&E role in lowering LCC is to take whatever action is necessary to control the proliferation of different types of equipment to satisfy similar or, worse yet, identical requirements. The LCC impact of proliferation on the DoD budget is probably beyond any accurate computation. But since we know it has its birthplace in R&D, we must do what is necessary to get the Services on the right track.

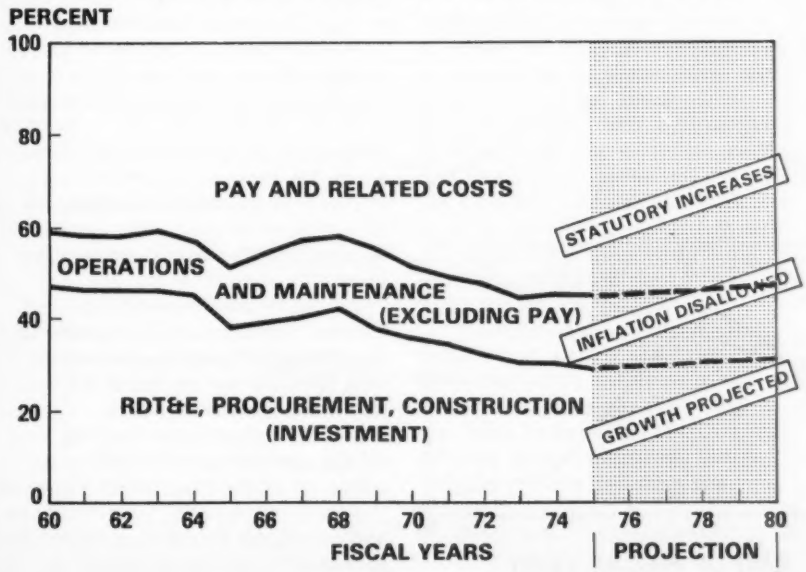
Conducting tests of new equipment in as realistic an environment as possible is the only way to find out what the developer is really delivering. The consequence of unrealistic testing manifests in major LCC escalations.

Witness the M60A2 tank Shillelagh missile program, which was the victim of a premature production go-ahead and changing requirements. Although only 500 tanks were involved, an ill-considered requirement and inadequate testing resulted in total replacement of the critical stabilization subsystem in order to overcome often as little as 15 minutes between major maintenance actions and repeated hydraulic system failures, as well as major problems with the combustible-cartridge case. There are undoubtedly many other skeletons around, but the point is that adequate, realistic testing is a must.

The LCC considerations of personnel skill levels and qualifications in support or operation of a weapon system must be given visibility and consideration early in the development planning phase. Recall that people costs are consuming the DoD budget. There aren't large enough reenlistment bonuses to keep a DoD-schooled person in the Service working 80 hours a week as an electrician when the aroma of union wages finds its way into the confines of a nuclear submarine. It has been said the "SSN" designation for nuclear attack submarines really stands for "Saturdays, Sundays, and Nights", as far as the technicians are concerned.

Chart # 4

DISTRIBUTION OF DEFENSE SPENDING



Lead Service Concept

Another initiative we are pursuing to reduce proliferation is the Lead Service concept. Under the Lead Service concept, the objective is to

U.S./USSR RELATIVE PRODUCTION RATE ESTIMATES

	U.S. 1972-74 AVG	USSR 1972-74 AVG	USSR/U.S. 1972-74
	462[1]	3,000	6.5:1
	860	4,400	5:1
	170	1,200	7:1
	920	710	1:1.3
	540	930	1.7:1
	0	10	
(General Purpose)	3	5	1.7:1
	11	39	3.5:1
SSBN	0	6	

INCLUDES 475 M60A2 RETROFIT IN 1973-74. AVERAGE M60A1 PRODUCTION WAS 303/YEAR

Chart # 6

SOVIET—U.S. DEFENSE EXPENDITURES AND MILITARY MANPOWER

DEFENSE EXPENDITURES

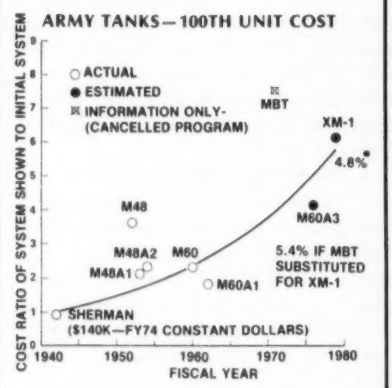
(Billion 1973 Dollars, excludes military assistance and civil defense)

MILITARY MANPOWER

(Millions)

Chart #5

Chart # 7



assign a single Service the responsibilities for the development, acquisition, and support of specific items of equipment for use by all the Services, with heavy emphasis on a supplier-customer relationship, as a means to control proliferation.

The functioning of the Lead Service technique is predicated on the thorough scrubbing of Service requirements to a common, austere, baseline and then satisfying varied needs through common equipments, and modular construction, with perhaps slight packaging variations to meet different environments.

The problem, of course, is to obtain full acceptance of this concept, in terms of reconciling it with our emphasis on strong Service program managers with substantial authority, who may want to implement an alternative that, for his program at least, may appear less costly. We have considerable inertia to overcome, but the Principal Deputy Director of Defense Research and Engineering is pushing the proliferation issue very hard, so we are hopeful that real progress will be made.

Standard electronic modules (SEMs) are being examined by a subpanel of the Electronics Panel of the Defense Materiel Specifications and Standards Board as a means to accrue LCC savings by virtue of

Chart # 8

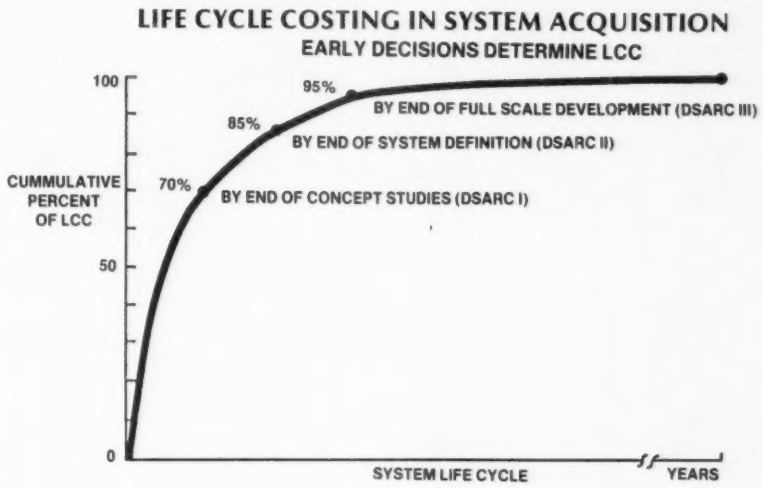


Chart # 9

their common application in numerous systems. This particular hardware concept addresses one of our fundamental LCC-oriented procurement problems, that is, the tendency to select a contractor based on the lowest bid for R&D or unit acquisition cost. It has been generally recognized that a SEM mechanization is not the approach one should use to achieve the lowest unit acquisition cost, but rather lowest LCC. As such, SEM can be and is being specified as the required hardware implementation on numerous Navy programs.

Unfortunately, in its present form, SEM is not applicable to all of our black boxes, and we are forced to find other ways to "police" LCC-oriented procurement, especially when a contracting officer is forced to accept the low bidder.

Implementation Problems

The DDR&E commitment to influencing LCC during the development process is not without its problems, not the least of which are:

- **Models**—In order to generate realistic models we need a significant improvement in our data collection and analysis techniques. As Chart II illustrates, while we have a fairly good handle on what systems cost to develop and procure, the present DoD accounting system is such that people costs and operating and maintenance costs, as they relate to specific systems, are not well understood. The OSD Support Cost Visibility Task Force has cracked this problem by addressing themselves to aircraft in 1975. Other areas will be tackled as well.
- **Data**—Our present data are not accurate enough or useful to designers of new equipment.
- **Low bidder**—Limited R&D funds often force a procurement to other than the contractor whose proposal could mean lower LCC.
- **Who to believe**—This is a real problem if you accept my thesis that the models and data are generally inadequate. The bias must be tuned out of the analysis, but it is a difficult job.
- **When is the development over?**—Not necessarily when we run out of R&D funds. Too many incomplete projects get released to production under the force of schedule, contract options, and personality. This is not conducive to minimizing LCC and requires a great deal more attention.

Key to LCC Control

Too often in the past, we in the R&D community have been seduced by the Lorelei call of increased performance and neglected to consider LCC implications. Too often, projected performance improvements failed to materialize in the field, because of our failure to consider the potential impact of the new item in terms of number and calibre of people to operate and maintain it, or that its

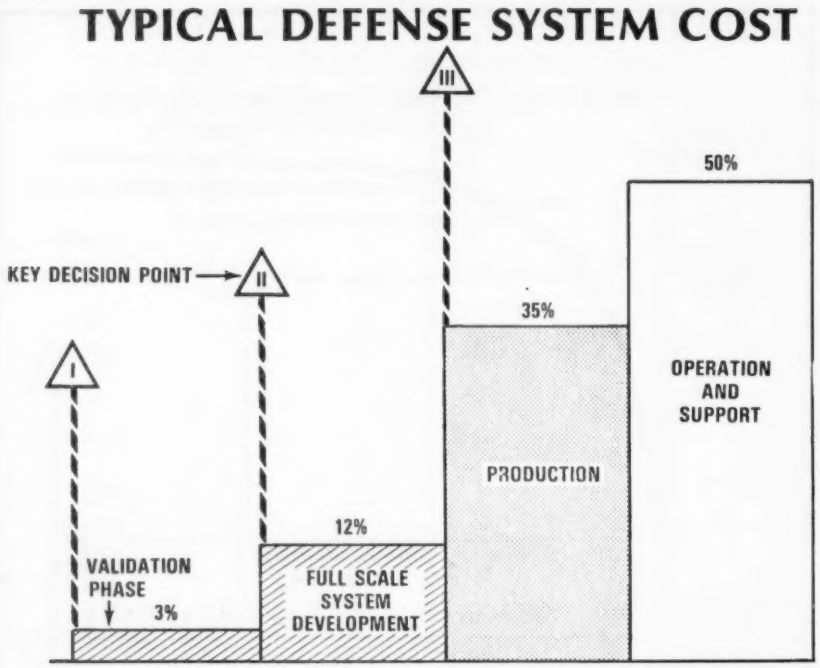


Chart # 10

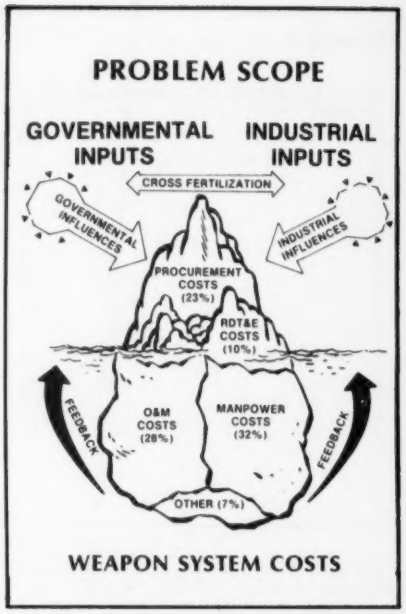


Chart # 11

increased complexity might result in less reliability and availability, and therefore higher LCC.

We welcome the expanded role of OSD(I&L) in sensitizing the Defense community to the need for early consideration of LCC in every program, and in alerting us to the LCC implications of increased performance we may desire. We are also pleased with the active interest of industry groups but DDR&E must face up to its major responsibility as the cognizant organization on the Secretary of Defense staff in a program's formulative stages, where over two thirds of a program's life cost gets "locked in."

DTC principles are also critical to controlling LCC. In my view, an initial DTC goal should be set in the earliest conceptual phases; cost is a feasibility issue. We can no longer afford high-cost solutions, because we can't buy the quantities we need. We plan to revise the DoD Source Selection Directive to give "points" for the bidder making the best trades. The importance of using technology to lower LCC rather than to push performance has already been indicated.

Industry can play a major role in informing the customer of the LCC implications of his "requirements". And industry needs to keep us informed, "back channeling" if necessary, when instances of non-compliance with our policy of increasing emphasis on lowering LCC are found. The assistance of industry in helping us to control LCC is vital, because developing affordable, operable, available systems is mandatory, if the United States is to continue to meet the President's objective of providing a national defense capability second to none.

Where the developer does not shoulder his responsibility to challenge all requirements, even the sacred cows, and where he does not scrub out the "gold plate", DDR&E will "micromanage" as necessary until the "word" on the need to control LCC permeates down through all the hundred faces of the customer. Considering that the average tour of one of the hundred persons in the decision chain between the Secretary of Defense and the working level is three years, and that there is a new face in the decision chain on every program an average of once every ten days, it becomes evident that the education process on the need for DTC and LCC principles is a never-ending one.

COMMANDERS DIGEST

Vol. 18, No. 16, October 16, 1975

A publication of the Department of Defense to provide official and professional information to commanders and key personnel on matters related to Defense policies, programs and interests, and to create better understanding and teamwork within the Department of Defense.

Published weekly by the American Forces Press Service, 1117 N. 19th St., Arlington, Va. 22209, a unified activity of the Office of Information for the Armed Forces, OASD (M&RA). Reproduction of content is authorized.

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Subscription Price: $18.75 domestic per year; $4.70 additional for foreign mailing; 40 cents per single copy.
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